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LETTER REQUIREMENT (LR) FOR DIRECTIONAL LOG PERIODIC ANTENNA (0--ETC(U)
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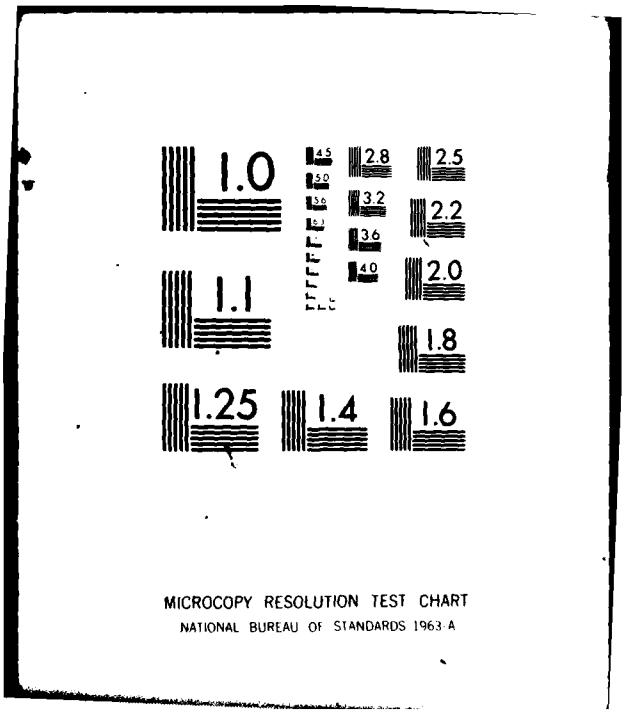
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DEPARTMENT OF THE ARMY
HEADQUARTERS UNITED STATES ARMY TRAINING AND DOCTRINE COMMAND
FORT MONROE, VIRGINIA 23651

(2)

ATCD-CT (6) (11) 1 Apr 1981

SUBJECT: Letter Requirement (LR) for Directional Log Periodic Antenna (ØE-314), USATRADOC ACN 46483

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1. Reference: AR 71-9.

2. Subject LR (Incl) was approved on 4 March 1981. The following information is applicable to this document.

a. System Designation: Non-major.

b. Materiel Developer: DARCOM.

c. Combat Developer: TRADOC.

d. User Representative: TRADOC.

e. Trainer: TRADOC.

f. Logistician: USALEA.

g. CARDS Reference Number: 0817R.

h. Operational Test Responsibility: TRADOC.

i. USATRADOC Proponent Activity: USASC&FG.

3. Subject Requirement Document is forwarded to Major Army Commands, other services and other DOD agencies for harmonization and to all other addressees for information.

FOR THE COMMANDER:

ROBERT W. WALKER
LTC, GS
Asst AG

1 Incl
as

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SUBJECT: Letter Requirement (LR) for Directional Log Periodic Antenna (OE-314) USATRADOC ACN 46483

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LETTER REQUIREMENT (LR)

FOR

DIRECTIONAL LOG PERIODIC ANTENNA

1. Title of the Item: Directional Log Periodic Antenna OE-314.

2. Statement of the Need:

a. A need exists for directional broadband VHF antenna for use within the 30-88 MHz frequency band during the 1981-1991 time frame with an IOC of May 1982. These antennas will provide an extended range capability for radio nets throughout the entire Army while reducing the radio frequency (RF) output power requirements and providing a degree of Electronic Counter-Counter Measure (ECCM) protection to the tactical radio system. This directional antenna is intended for use with both current VHF-FM tactical net radios (VRC-12/PRC-77/PRC-25 series) and subsequently with the Single Channel Ground Airborne Radio Subsystems-VHF (SINCGARS-V) radios.

b. Cards Reference Number: 0817R.

3. Justification:

a. The Soviet Union has the capability of denying the use of the VHF frequency band to forward deployed US Army tactical ground forces by employing jamming. While long recognized as a vulnerability, the only alternatives open to US Army radio operators in the past to evade the effective use of jammers were to increase power, change frequencies, and/or displace, such that terrain might shield the receiver from the threat jammer. The US Army has long awaited the advent of an effective ECCM device/procedure that allows continued radio communication in a hostile electronic warfare environment. The directional log periodic antenna can provide a degree of protection not offered by the current VHF-FM omni-directional antennas.

b. The current omni-directional antennas (RC-292 and OE-254) when employed in forward combat areas transmit and receive signals equally in all directions and provide as strong a signal to enemy EW units as they do to friendly units. The employment of a directional log periodic antenna will decrease VHF-FM radio susceptibility to hostile EW operations (e.g., direction finding, jamming, and interception) and enhance the communications range, when required, by directing the maximum signal in the direction of the desired friendly unit.

4. Basis of Issue:

The Directional Log Periodic Antenna will be doctrinally employed in essential command and control, and fire direction single channel radio nets from platoon to division (lower to higher) echelon in forward areas to increase communications range and overcome jamming. Basic applications include the

divisional command/operations/intelligence nets, brigade/group command/ operations/intelligence nets, and battalion command/operations/intelligence nets as well as those FM radios used by separate brigades in their command/ operations/intelligence nets.

5. Principle Characteristics:

a. A technical description of the Directional Log Periodic Broadband VHF Antenna is inherent within the principle characteristics. These characteristics have not been arranged in order of priority.

b. The general purpose design for the Directional Log Periodic Antenna system shall have the following features:

(1) Be broadband over the frequency range of 30-88 MHz without physical tuning by the operator.

(2) Chemical agent resistant paint and material should be used to maximum extent possible.

(3) Be designed with appropriate considerations given to human factors engineering IAW provisions of AR 602-1 and MIL-STD-1472.

(4) Be designed to provide maximum safety for personnel and equipment during storage, transportation, operation, and maintenance IAW provisions of MIL-STD-454 and MIL-STD-882.

(5) Voltage Standing Wave Ratio (VSWR) not to exceed 2:1 from 30-88 MHz.

(6) Shall have a minimum service life of at least ten years.

(7) Meet operation, storage, and transmit requirements as specified by the 4 climatic design types as defined in AR 70-38, as well as withstand exposure to dust, fungal growth and salt water spray.

(8) Contain input and output characteristics compatible with VHF-FM radios (nominal 50 ohms impedence).

(9) Nuclear survivability is not required because a sufficient density will exist on the battlefield to allow timely replacement of a damaged or destroyed antenna system.

(10) Handle power levels up to 350 watts. (For use with the 5 port Transceiver Multiplexer)

(11) The antenna system will include a mast having a minimum height of 10 meters.

(12) The antenna system will include all necessary guying assemblies, stakes, base plate, tools, and other ancillary equipment required to make a complete antenna system.

(13) The antenna system will include all necessary coaxial cables and cable adapters for radio sets AN/PRC-25 and AN/PRC-77 (series), and the AN/VRC-12 (family) and the SINCGARS-V radio systems.

(14) The antenna system will be capable of being assembled and erected by two individuals in less than 20 minutes.

(15) The antenna system will be designed to fit into two packages (one for the antenna and one for the mast) which can be transported by tactical vehicle.

(16) The antenna system design will provide for ease of field maintenance and minimize user logistic requirements.

(17) Forward gain of at least 3.0 dB average but not less than 1 dB compared to a reference dipole over the 30-88 MHz frequency band.

(18) Exhibit a front-to-back ratio of 5.5 dB average (but not less than 4.0 dB) in the frequency range of 30-50 MHz, and 8.5 dB average (but not less than 7.5 dB) in the frequency range 50-88 MHz.

(19) Operate with either horizontal or vertical polarization with the capability to change polarization within a time limit of 1 minute.

(20) Capable of being ground mounted on a mast, on a vehicle (e.g., M-113, M-577 or 2½-ton truck (except tank)) or on a shelter.

(21) Capable of an azimuthal directional change within a time limit of one minute.

(22) Antenna weight not to exceed 37 pounds.

(23) Mast weight not to exceed 72 pounds.

(24) Antenna mast supplied will be a quick erect mast similiar to AEL Model MAS 1576.

(25) The antenna will include a standard military magentic compass to aid in alignment of the antenna system.

c. RAM is not required for this antenna. The antenna RAM is inherent within the material strength of the material which comprises the antenna. In addition, the antenna is a passive type item in that it is not designed to move, shoot, operate or wear out.

6. Testing Required. Limited testing will be required. This item is in the category of low risk development/high probability of success. The basic antenna design principles have been demonstrated as evidenced in the Army Electronic Command Memorandum for Record, dated 27 April 1979, Subject: Evaluation of Hy-Gain Antennas, Log Periodic LP-1403 and Discon; and CORADCOM

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Memorandum for Record, dated 4 Oct 77, Subject: Evaluation of AEL Inc Portable Log Periodic Antenna. These tests demonstrated the feasibility of this antenna design. Follow-on evaluation (FOE) will validate and verify the System Support Package (SSP), to include training requirements.

7. Logistical Support Implications.

a. No special or new test equipment will be required.

b. Channels of supply, resupply, logistics support, and maintenance support will be the same as for Antenna Equipment RC-292 and OE-254.

c. An integrated Logistic Support (ILS) Plan will be prepared and updated commensurate with antenna design evolution and will address each of the ILS elements.

d. Antenna logistics support requirements (e.g., MOS and maintenance skills) will be the same as for Antenna Equipment RC-292 and OE-254.

e. A system Support Package will be fully validated and verified by official testing, be finalized and available prior to IOC, and be coordinated with the user via a Materiel Fielding Plan.

f. A Logistic Support Analysis will be performed to effect logistic influence on design, optimize the logistic support concept, and generate logistic data required to support the ILS elements and SSP acquisition.

8. Training Assessment.

The materiel developer and TRADOC proponent will develop a complete training system to support the directional log periodic antenna system. This training system will include a complete skill performance aids (SPAS) package and all training devices and training materials necessary to provide individual and collective training in both institution and units.

a. The TRADOC proponent will provide the materiel developer with information on the target user populations, and will assist the materiel developer in identifying any unusual training requirements inherent in the intended user population. The length of training time available to train the target operators and maintainers will be specified (separately for each) as a maximum number of hours/weeks.

b. The training subsystem developed will be based upon a precisely defined set of performance requirements obtained through analysis or collection of logistic support analysis (LSA) data generated IAW DARCOM PAM 750-16. Based on the results of this analysis, DARCOM/TRADOC will jointly agree upon a detailed task list covering all operator and maintenance tasks for this system.

c. The materiel developer will procure a complete SPAS package for the systems, to include TMs and training materials. The reading grade level (RGL) of the training, technical, and equipment publications will not exceed $\pm$ 1.0 of the RGL provided in the Target Audience Description. The TRADOC proponent will determine the RGL of these publications using the Flesch-Kincaid Readability Formula. The SPAS package will be developed and funded IAW the DARCOM/TRADOC SPAS Policy Statement.

d. Requirements for training devices identified in the demonstration and validation phase, and for which no separate requirements documents exist, are as follows: NONE.

e. The need for additional training requirements and materials, such as classroom trainers or collective trainers, which were not identified in demonstration and validation phase, will be investigated. The necessary TRADOC/DARCOM Developer responsibilities and resources to develop these additional training materials will be established and requirements documents will be prepared as appropriate.

f. The TRADOC proponent will prepare/update the Individual and Collective Training Plan (ICTP) which will describe all system training requirements. The ICTP will specify MOS, skill levels, jobs and tasks to be trained using SPAS materials and will also describe the requirements for materiel developer training for service school staff and faculty.

g. TRADOC will develop training products not included in the SPAS package or developed by the materiel developer as the result of a DARCOM/TRADOC agreement. These products include the ARTEP, SQT, Soldier's Mantuals, TEC Materials, and motion pictures.

h. The training subsystem developed by the materiel developer will be made available to the TRADOC proponent school in sufficient time to allow preparation of Training Test Support Package and training of follow-on evaluation (FOE) test player personnel.

i. All elements of the training support package will be available in final form for system IOC.

j. The materiel developer will provide operating instructions on a durable medium, such as a plastic card, which will accompany the antenna. These instructions will provide simple directions for installation and removal of the antenna, and siting instructions which address both communications operations and ECCM aspects. Organizational and higher level maintenance and supply instructions will be provided by separate TM. Final form and content of operational maintenance literature and introductory training will be determined by the materiel developer as a result of task analysis.

9. Manpower/Force Structure Assessment: No requirement for new MOS's for operator or maintenance personnel is foreseen.

10. Other Services or Allied nation interest. The USMC has expressed interest in the directional broadband VHF antenna and will continue to monitor the development and testing of the antenna OE-314.

11. Life Cycle Cost Assessment:

a. Summary of estimated life-cycle costs as expressed in constant FY-81 and current (inflated) dollars ($ M-Millions)

	CONSTANT DOLLARS			INFLATED DOLLARS		
	LOW	MOST LIKELY	HIGH	LOW	MOST LIKELY	HIGH
R&D	0		0	0		0
INVESTMENT	10.344	10.888	11.977	13.868	14.598	16.058
O&S	6.090	6.410	7.051	11.002	11.581	12.739
TOTAL	16.434	17.298	19.028	24.870	26.179	28.797

b. Quantity/unit cost, estimated unit flyaway and unit procurement costs, expressed in constant FY-81 dollars.

ITEM	QUANTITY	UNIT FLYAWAY	UNIT PROCUREMENT
OE-314	3500	2724	3111

Note 1: Quantity of Prototypes - 15

Note 2: Sunk costs (excluded from paragraph a)

R&D: Actual 149K
Constant FY-81 - 184K

c. Recommended funding profile expressed in constant FY-81 and current dollars ($ M-Millions).

INVESTMENT PHASE

	81	82	83	84	85	Total
Quantity	620	720	720	720	720	3500
Approved Prog (Cur)	0	0	0	0	0	0
Estimate (Con)	2.238	2.187	2.187	2.138	2.138	10.888
Estimate (Cur)	2.937	2.938	2.946	2.887	2.890	14.598
Variance (Cur)	-2.937	-2.938	-2.946	-2.887	-2.890	-14.598

Note 3: Inflation has been incorporated in accordance with DACS-PBC Memo, 11 Aug 80

Note 4: Source documents for quantity are:

Message #P070934Z Mar 79, Subject: Urgent requirement for antennas, from USAREUR, and Draft BOIP.

Log Periodic Antenna

Antenna Group OE-314()/GRC

A prototype (commercial equivalent) of the Portable Log Periodic Antenna is the AEL Model APN-1596 with Quick Erect Mast MAS-1576. The OE-314 Log Periodic Antenna is a directional gain antenna for FM combat net radio. Its directional characteristics afford an increase in range, and a reduced susceptibility to enemy intercept.

1. R&D Costs

The labs procured a quantity of 15 each of a QE Mast, MAS-1576 and a Portable Log Periodic Antenna AEL Model APM-1596. A copy of the Materiel Request, amounting to $59,475, is attached. In-house expenditures for FY 78 were 25K, FY 79, 30K, and FY80, 35K. The in-house engineering efforts were directed towards the testing of the developed item. All R&D costs (FY80 and earlier) are considered sunk. The CG has directed that procurement of MIL versions of the antenna begin ASAP.

Total actual sunk 59 + 90 = 149K
59,475 ÷ .8401 = 70,795 (Historical Compound Index, 80 constant$)
70,795 X 1.096 = 77,591 (Compound Index, 81 constant $)
78 25 ÷ .8401 X 1.096 = 32615
79 30 ÷ 1.9242 X 1.096 = 35,577 Historical & Compound Indices
80 35 X 1.0000 X 1.096 = 38360
Total FY81 $ = 77,591 + 32,615 + 35,577 + 38,360 = $184,143

2. Procurement Costs

a. Fifteen of the commercial versions were purchased in FY78, at a cost of $2780 each. In addition, 15 of the QE Masts were purchased at a cost of $1185 each. A multiyear procurement is currently planned to buy the projected quantity required. (3500) Semi-automated production processes are anticipated and a 90% production experience curve is assumed. The Lab engineering representatives have projected that the MIL version would be equivalent in complexity to the experience data provided by the labs: $A = y/x^b$, the first unit cost of the antenna is $4,196. The mast should experience less of a quantity/cost reduction, as this is currently a high volume production item. A 92% slope was assumed. The first unit cost for this item amounted to $1,642. Inflation factors are based on 25 March 1980 CORADCOM Historical Indices and 11 August 1980 DA Inflation Guidance. The tables were used to update the FY78$ to reflect FY81 based projections of funding requirements.

Historical OPA Index - 78 - 80 - .8522
DA OPA Index, 80 81 - .9099
Product = .7754 to adjust FY78$ to FY81 base.

Antenna: Y = 4196 (3500) - .152 = 1214
Y = 1642 (3500) - .12029= 615
1829 ÷ .7754 = 2359

FY81 - 620 x 2359 = 1463K
82-85 - 720 x 2369 = 1698K
Total -3500 x 2359 = 8257K

FY 81	620		1.1748	= 1718
82	720		1.2615	= 2143
83	720	X 2359 X	1.3455	= 2285
84	720		1.4297	= 2428
85	720		1.5183	= 2579
			11153	÷ 3500 = 3186

FY81 620 x 3186 = 1975K
82-85 720 x 3186 = 2294K
Total-3500 x 3186 = 1115K

b. Tooling

In this category are non-recurring initial production, facility costs - including tooling, test equipment, and non-recurring production engineering costs. Per Fred C. Hartmeyer, for the 1000 volume production, a composite factor of 8.7% of recurring manufacturing was considered representative for a quantity of 1000 units. For 10,000 units a factor of 4.5% was representative. Extrapolating between the two values a factor of 6.57% is appropriate.

Constant	.06575 X 8257K	= 543K
Current	.06575 X 11151K	= 733K

c. Auxiliary Equipment None

d. Government Engineering

Laboratory projections for support of the initial procurement, first article test, and procurement data package was 75K (15 man-months) for FY 81 and 8 man-months (40K) for each year thereafter. In-house (PMO) projected costs for each year are 1/4 man-year (15K/year).

Other in-house costs include:

Production Engineering and Product Assurance & Test at .25 man-years/year for each.

FY	PE + PAT	Lab + PM	MY$	Total $ (FY81)	Inf Factor	Total $ (Inf)
81	.25 + .25	1.25 + .25	60K	120	1.091	131
82	.25 + .25	2/3 + .25	60K	85	1.091 x 1.07	99
83	.25 + .25	2/3 + .25	60K	85	(82) x 1.07	106
84	.25	1/3	60K	35	(83) x 1.07	47
85	.25	1/3	60K	35	(84) x 1.07	50
				360		433

e. Engineering Change Orders

Computed as 2% of recurring manufacturing cost.

Constant .02 x 8257K = 165K

Current .02 x11151K = 223K

f. Documentation

As provided by CENCOMS, an analogy was drawn between this antenna system and the OE-254. Based on similarity of the systems, CENCOMS provided the following forecasts of costs (FY80$):

LRIP production data:	90K
F/A test report	10
Group C Failure Reports	5
	105K (FY80 constant)

105 x 1.099 = 115.4 (FY81 constant)
115.4 x 1.1748 = 136K (FY81 inflated)

g. Testing

The analogy with the OE-254 was again used. DT-III for the OE-254 included 60K for labor and 15K for materials (FY80$). OT-III amounted to 75K labor and 25K material. (FY80$). In FY81$ this total would be 175 x 1.099 = 192K (constant $). In lieu of DT-III a first article test is scheduled to include PQT-C and is assumed to require the same scope of work.

Inflated -192 x 1.1748 = 226K

h. Initial Spares & Repair Parts

This antenna is assumed to have a failure factor similar to the OE-254. An initial fielding of the OE-254 resulted in a deployment of 1300 systems, with 200 being disassembled to provide initial spares. (15.39%). By analogy a 15% factor was assumed for ISRP.

Constant .15 x 8257 = 1239K
Current .15 x 11151 = 1673K

i. First Destination Transportation

The relationship
C = 1091.34 + 0.03114 X was used
Where C = Cost in FY78$
X = Weight in pounds
Each OE-314 weighs 110 pounds. Total weight is 110 x 3500 = 385,000
C = 13,080 (FY78$)
= 13,080 ÷ .7754 = 16869 (FY81 constant)

$\frac{16869}{8257}$ - .00204 ∴ Inflated FDT = .00204 (11,151,000) = 22748

Funding Summary - Procurement

Constant FY81$		Current
3500	Quantity	3500
8257	Hardware	11151
543	Tooling	733
360	Govt Eng'g	433
165	ECO	223
115	Documentation	136
192	Testing	226
1239	ISRP	1673
17	FDT	23
10888		14598

Funding Profile - Constant$

FY	81	82	83	84	85	Total
Q	620	720	720	720	720	3500
Hardware	1465	1698	1698	1698	1698	8257
Tooling	95	112	112	112	112	543
Govt Eng'g	120	85	85	35	35	360
ECO	29	34	34	34	34	165
Documentation	115					115
Testing	192					192
ISRP	219	255	255	255	255	1239
FDT	3	3	3	4	4	17
Total	2.238	2.187	2.187	2.138	2.138	10.888

Funding Profile - Inflated

Hardware	1975	2294	2294	2294	2294	11151
Tooling	129	151	151	151	151	733
Govt Eng'g	131	99	106	47	50	433
ECO	39	46	46	46	46	223
Documentation	136					136
Testing	226					226
ISRP	297	344	344	344	344	1673
FDT	4	4	5	5	5	23
Total	2.937	2.938	2.946	2.887	2.890	14.598

Unit Procurement Cost (FY81$)
10.888 ÷ 3500 = 3111

Unit Flyaway Cost (Total-data-ISRP)
10.888 - .115 - 1.239 = 9.534 ÷ 3500 = 2724

3. O&S

a. Operating and support cost projections are based on the analogous OE-254 antenna system. For that particular system:

1) No operator costs - no training required
2) No METT team required
3) The device is a passive, stationary device without a specific wear-out characteristic. Virtually all failures would be due to externally caused handling/transportation caused damage.

b. No field data is available on the OE-254 at this time. However, the RC-292, an antenna which the OE-254 is replacing, is being replaced at a rate of 600 per year and has a fielded density of 26,000 units. This is an attrition rate of 2.31%. For the purposes of this analysis, an attrition (consumption) rate of 2.5% is assumed.

c. Failure rates for the antennas have not been determined. However, based on an analogy with the OE-254, the ops readiness float for the antennas will be 7.9% which provides an operational availability of 90%. This ORF for the OE-254 was for a density of 7100 units. An ORF of 7.9% means a failure rate of .079/.90 or 8.78% per year. Per TB 750-91-27, the maintenance expenditure limit for an antenna system should not exceed 60% of the hardware cost. This will be used as the basis for O&S cost (Maintenance Computation).

d. Economic life is 10 years, with deliveries beginning in FY 83, full strength achieved in FY86, and phase-out beginning in FY93, completed in FY 96.

e. Based on the above assumptions, the following annual O&S costs per year are projected:

Consumption:
2.5%/year or .025 x 8.257 = 206K/year

Maintenance (Material + Labor)
.0878 x .6 x 8.257 = 435K/year

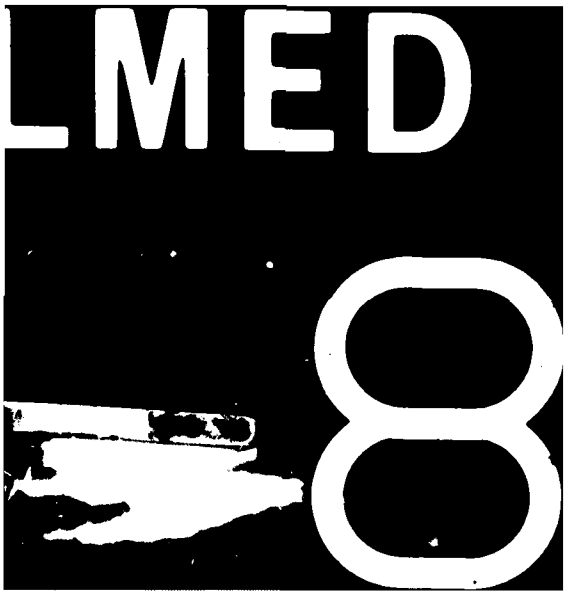
Total O&S/year = 641K

Inflated: The methodology for computing the inflated O&S costs is to multiply the uniform constant $ rate by the sum of the 10-year inflation rate. The period FY85-94 was used. The sum of the indices is: 18.0673.
Therefore: 18.0673 x 641 = 11.581M

Range Estimate: Based on discussions with laboratory personnel, a high confidence appears that the most likely cost estimate will not be exceeded by more than +10%. This factor was applied to the most likely estimate to compute a "high" estimate. The labs further felt that an estimate of -50% is the most that could be applied to the low estimate, based on a knowledge of potential manufacturers.

CARL E VUONO
Major General, GS
Deputy Chief of Staff
for Combat Developments

STAN R. SHERIDAN
Major General, USA
Director for Development
and Engineering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